The invention claimed is:

1. A method of fabricating a solid-state energy-storage device, comprising:
providing a substrate;
depositing a first layer on the substrate by:
(a) depositing a first material to a location on the substrate, and
(b) supplying an energized second material different than the first material towards the substrate adjacent the location to control growth of the first material at the location;
forming an electrolyte second layer on the first layer; and
forming a third layer on the second layer.

2. The method of claim 1, wherein depositing the first layer includes using physical vapor deposition to direct the first material to the location on the substrate.

3. The method of claim 1, wherein the supplying the energized second material includes supplying ions having an energy within the range of about 5 to about 3000 eV.

4. The method of claim 3, wherein supplying energized ions includes supplying ions from a source gas including O_2.

5. The method of claim 3, wherein supplying energized ions includes supplying ions from a source gas including N_2.

6. The method of claim 3, wherein supplying energized ions includes supplying ions from a source gas including a noble gas.

7. The method of claim 3, wherein supplying energized ions includes supplying ions from a source gas including argon.

8. The method of claim 3, wherein supplying energized ions includes supplying ions from a source gas including a hydrocarbon precursor.

9. The method of claim 3, wherein supplying energized ions includes focusing a beam of the ions at the location on the substrate.

10. The method of claim 3, wherein supplying energized ions includes supplying a non-focused beam of the ions.

11. The method of claim 3, wherein supplying energized ions includes supplying ions having an energy within the range of about 5 eV to about 200 eV.

12. The method of claim 3, wherein supplying energized ions of the second material includes controlling stoichiometry of a growing film of first material.

13. The method of claim 3, wherein supplying energized ions includes supplying ions having an energy within the range of about 10 eV to about 500 eV.

14. The method of claim 3, wherein supplying energized ions includes supplying ions having an energy within the range of about 60 eV to about 150 eV.

15. The method of claim 3, wherein supplying energized ions includes supplying ions having an energy of about 140 eV.

16. The method of claim 1, wherein providing the substrate includes forming a first contact layer on the substrate that at least partially separates the first layer from the substrate.

17. The method of claim 16, wherein providing the substrate includes forming a second contact layer on the substrate separate from the first contact layer.

18. The method of claim 1, wherein at least one of depositing the first film, forming the electrolyte second film or forming the third film includes using chemical vapor deposition to direct the primary material toward the substrate.

19. The method of claim 1, wherein depositing the first layer includes depositing an intercalation material in the first layer to have a crystal orientation essentially perpendicular to a boundary between the first layer and the second layer.

20. The method of claim 19, wherein depositing the intercalation first layer includes growing crystallite size of at least about 100 Angstroms.

21. The method of claim 19, wherein depositing the intercalation first layer includes growing crystallite size of at least about 200 Angstroms.

22. The method of claim 19, wherein depositing the intercalation first layer includes growing crystallite size of about 240 Angstroms.

23. The method of claim 22, wherein depositing the intercalation first layer includes depositing a $LiCoO_2$ material as the first layer.

24. The method of claim 23, wherein depositing the $LiCoO_2$ intercalation first layer includes depositing the $LiCoO_2$ intercalation first layer as a cathode layer.

25. The method of claim 1, wherein forming the electrolyte second layer on the first layer includes depositing a first material to a location on the substrate and at least partially in contact with the first layer, and supplying energized ions of a second material different than the first material to the location on the substrate to form the electrolyte second layer.

26. The method of claim 1, wherein forming the third layer on the electrolyte second layer includes depositing a third material to a second location at least partially in contact with the electrolyte second layer and separate from the first layer, and supplying energized ions of a fourth material different than the third material to the second location to control growth of a crystalline structure of the third material at the location to form the third layer.

27. The method of claim 26, wherein forming the third layer includes forming an anode for a thin-film battery.

28. The method of claim 1, wherein supplying the energized second material includes supplying particles of the energized second material along a path that is not coincident with a path along which the first material travels.

29. The method of claim 1, wherein supplying the energized second material includes supplying energized ions to the location on the substrate.

30. The method of claim 1, wherein providing the substrate includes providing a substrate having a thermal degradation temperature of less than 700 degrees Celsius.

31. The method of claim 1, wherein providing the substrate includes providing a substrate having a thermal degradation temperature of less than about 300 degrees Celsius.

32. The method of claim 1, wherein providing the substrate includes providing a substrate having a thermal degradation temperature of less than about 250 degrees Celsius.

33. The method of claim 1, wherein the supplying the energized second material includes controlling growth of the first material into a crystalline structure.

34. The method of claim 1, wherein the supplying of the energized second material includes supplying energized ions.

35. A method of fabricating a thin-film, rechargeable lithium battery, comprising:

providing a substrate having a thermal degradation temperature of less than 700 degrees;

depositing a first film on the substrate, wherein depositing the first film includes:

depositing first electrode material using a deposition source; and

supplying particles energized above about 5 eV from a second source such that the particles provide energy to the first electrode material to deposit the first electrode material into a highly ordered crystal film;

forming an electrolyte second film so as to be in contact with the first film; and

forming a fourth film in contact with the third film and separate from the first film, the fourth electrode film including a second electrode material;

wherein the first electrode material or the second electrode material or both

include a metal or an intercalation material.

36. The method of claim 35, wherein the intercalation material is a lithium intercalation material.

37. The method of claim 35, wherein providing the substrate includes keeping the substrate free from a high temperature anneal.

38. The method of claim 35, wherein providing the substrate includes providing a contact film in contact with the first film, the contact film being non-reactive with the first film.

39. The method of claim 36, wherein the contact film is intermediate the substrate and the first film.

40. The method of claim 35, wherein the deposition source is a physical vapor deposition source.

41. The method of claim 35, wherein forming the electrolyte second film includes:

depositing electrolyte material using an electrolyte deposition source; and

supplying ions energized above 5 eV from an electrolyte second source such that the ions provide energy to the electrolyte material to deposit the electrolyte material.

42. The method of claim 41, wherein forming the electrolyte second film includes depositing an electrolyte material that allows transport of lithium ions through the second layer.

43. The method of claim 41, wherein supplying ions energized above about 5 eV in depositing the electrolyte second layer includes supplying energized ions at an energy below about 500 eV.

44. The method of claim 35, wherein forming the third film includes:

depositing a second electrode material using a second deposition source; and

supplying ions energized above 5 eV from a second ion source such that the ions provide energy to the second electrode material to deposit the second electrode material into a highly ordered crystal film absent post-deposition anneal.

45. The method of claim 44, wherein supplying ions energized above about 5 eV in depositing the third layer includes supplying energized ions at an energy below about 500 eV.

46. The method of claim 35, wherein providing the substrate includes providing a substrate with a thermal degradation temperature of less than about 250 degrees Celsius.

47. The method of claim 35, wherein supplying ions energized above about 5 eV in depositing the first layer includes supplying energized ions at an energy below about 500 eV.

48. The method of claim 35, wherein providing the substrate includes positioning the substrate on a cooled surface such that heat from the depositing of at least one of the first film, second film, and third film is thermally balanced by the cooled surface so that the substrate does not thermally degrade.

49. The method of claim 35, wherein providing the substrate includes positioning a flexible substrate in contact with a curved cooled surface during

depositing of at least one of the first film, second film, and third film.

50. The method of claim 35, wherein depositing the first film includes first depositing a seed material on the substrate to assist in the low-energy deposition of lithium intercalation material for the first film on the substrate in order to control a crystal characteristic of the first film.

51. The method of claim 50, wherein depositing seed material includes depositing a seed material having a surface free energy that is higher than a surface free energy of the lithium intercalation material of the first film.

52. The method of claim 50, wherein depositing seed material includes depositing an amorphous seed material in order to diminish undesirable growth structures of the lithium intercalation material of the first film.

53. The method of claim 50, wherein depositing seed material includes depositing a nanocrystalline seed material with fine grains in order to diminish undesirable growth structures of the lithium intercalation material of the first film.

54. The method of claim 50, wherein depositing seed material includes depositing an electrically conductive seed material.

55. The method of claim 50, wherein depositing seed material includes depositing a seed material comprising one or more of Ta, TaN, Cr, and CrN.

56. The method of claim 50, wherein depositing seed material includes depositing a seed material comprising one or more of W, WN, Ru, and RuN.

57. A rechargeable energy-storage device, comprising:

a substrate having a melting point less than 700 degrees;

a first film adjacent to the substrate, the first film including an electrode material deposited using particles that have energy above about 5 eV such that the particles provide energy to the electrode material to form the electrode material into a highly ordered crystal film;

an electrolyte second film adjacent to the first film;

a third film adjacent the electrolyte second film and separate from the first film, the third film including a second electrode material; and

wherein the first electrode material or the second electrode material or both the first and second electrode materials are a metal or an intercalation material,

whereby the substrate is not subject to a high temperature anneal.

58. The energy-storage device of claim 56, wherein the substrate has a thermal degradation temperature of less than about 300 degrees Celsius.

59. The energy-storage device of claim 56, wherein the substrate has a thermal degradation temperature of less than about 250 degrees Celsius.

60. The energy-storage device of claim 56, wherein the substrate includes a contact layer, and the first film is non-reactive with and formed on the contact layer.

61. The energy-storage device of claim 56, wherein the third film includes a second electrode material deposited using particles that have an energy above about 5 eV such that the particles provide energy to the electrode material to form the electrode material into a highly ordered crystal film.

62. The energy-storage device of claim 56, wherein the electrolyte second film is a lithium ion transporting film.

63. The energy-storage device of claim 56, wherein the first film is a cathode having a crystallite size of greater than about 240Å.

64. The energy-storage device of claim 63, wherein the first film is a cathode having a crystalline orientation with lattice planes essentially perpendicular to a boundary between the cathode first film and the electrolyte second film.

65. A method of fabricating a solid-state energy-storage device, comprising:

providing a substrate;

forming a seed film on the substrate;

forming a first film on the seed film by:

(a) depositing a first material to a location on the seed film, and

(b) supplying a second material different than the first material adjacent the location to control growth of a crystalline structure of the first material at the location;

forming an electrolyte second film on the first film; and

forming a third film on the electrolyte second film.

66. The method of claim 65, wherein forming the third film includes forming a second seed film on a surface of the electrolyte second film and thereafter forming the third film on the second seed film.

67. The method of claim 65, wherein forming the second seed film includes depositing a seed material having a surface free energy that is higher than a surface free energy of the third film.

68. The method of claim 66, wherein the third film includes a lithium intercalation material, and wherein forming the second seed film includes depositing an amorphous seed material to diminish undesirable growth structures of the lithium intercalation material of the third film.

69. The method of claim 66, wherein the third film includes a lithium intercalation material, and wherein forming the second seed film includes depositing a nanocrystalline seed material with fine grains to diminish undesirable growth structures of the lithium intercalation material of the third film.

70. The method of claim 66, wherein forming the second seed film includes depositing an electrically conductive seed material.

71. The method of claim 70, wherein depositing seed material includes depositing a seed material comprising one or more of Ta, TaN, Cr, and CrN.

72. The method of claim 70, wherein depositing seed material includes depositing a seed material comprising one or more of, W, WN, Ru, and RuN.

73. The method of claim 65, wherein forming the seed film includes depositing a seed material having a surface free energy that is higher than a surface free energy of the first film.

74. The method of claim 65, wherein the first film includes a lithium intercalation material, and wherein forming the seed film includes depositing an amorphous seed material to diminish undesirable growth structures of the lithium intercalation material of the first film.

75. The method of claim 65, wherein the first film includes a lithium intercalation material, and wherein forming the seed film includes depositing a nanocrystalline seed material with fine grains to diminish undesirable growth structures of the lithium intercalation material of the first film.

76. The method of claim 65, wherein forming the seed film includes depositing an electrically conductive seed material.

77. The method of claim 76, wherein depositing seed material includes depositing a seed material comprising one or more of Ta, TaN, Cr, and CrN.

78. The method of claim 76, wherein depositing seed material includes depositing a seed material comprising one or more of, W, WN, Ru, and RuN.

79. A thin-film, rechargeable energy-storage device, comprising:

a substrate having a melting point of less than 700 degrees;

a first film in contact with the substrate;

an electrolyte second film in contact with the first film; and

a third film in contact with the electrolyte second film, the third film being separate from the first film,

wherein the first film or the third film or both the first and third films includes an intercalation material.

80. The energy-storage device of claim 79, wherein both the first film and the third film are formed of a lithium intercalation material.

81. The energy-storage device of claim 79, wherein the first film and the third film each have a highly ordered crystal structure, whereby the crystal structure provides superior energy charge/discharge rates and electrical energy density.

82. The energy-storage device of claim 79, wherein the substrate has a thermal degradation temperature of less than about 300 degrees Celsius.

83. The energy-storage device of claim 79, wherein the substrate has a thermal degradation temperature of less than about 200 degrees Celsius.

84. The energy-storage device of claim 79, wherein the substrate has a thermal degradation temperature of less than about 100 degrees Celsius.

85. The energy-storage device of claim 79, wherein the first film is a cathode having a crystallite size of greater than about 240Å.

86. The energy-storage device of claim 79, wherein the first film is a cathode having a crystalline orientation with the lattice planes essentially perpendicular to a boundary between the cathode first film and the electrolyte second film.

87. The energy-storage device of claim 79, wherein the third film is an anode having a crystallite size of greater than about 240Å.

88. The energy-storage device of claim 79, wherein the second film is an anode having a crystalline orientation with lattice planes essentially perpendicular to a boundary between the anode third film and the electrolyte second film.

89. A thin-film, rechargeable energy-storage device, comprising:

a substrate;

a seed layer adjacent to the substrate;

a first film on the seed layer;

an electrolyte second film adjacent to the first film; and

a third film adjacent to the electrolyte second film, wherein the first film or the third film or both the first and third films include an intercalation material.

90. The energy-storage device of claim 89, wherein the substrate has a thermal degradation temperature of less than 700 degrees Celsius.

91. The energy-storage device of claim 89, wherein the substrate has a thermal degradation temperature of less than about 250 degrees Celsius.

92. The energy-storage device of claim 89, wherein the seed layer has a surface free energy that is higher than a surface free energy of the intercalation material of the first film.

93. The energy-storage device of claim 89, wherein the seed layer is amorphous to diminish undesirable growth structures of the intercalation material of the first film.

94. The energy-storage device of claim 89, wherein the seed layer is a fine grained polycrystalline seed material to diminish undesirable growth structures of the intercalation material of the first film.

95. The energy-storage device of claim 89, wherein the seed layer is an electrically conductive seed material.

96. The energy-storage device of claim 89, wherein the seed material includes one or more of Ta, TaN, Cr, and CrN.

97. The energy-storage device of claim 89, wherein the seed material includes one or more of W, WN, Ru, and RuN.

98. The energy-storage device of claim 89, wherein the substrate includes a contact layer, and the seed layer is on the contact layer.

99. The energy-storage device of claim 98, wherein the seed layer is electrically conductive.

100. The energy-storage device of claim 89, wherein both the first film and the second film are formed of lithium intercalation material such that the energy-storage device includes a lithium ion rechargeable battery.

101. A method of fabricating a solid-state energy-storage device, comprising:

providing a substrate;

depositing a first layer on the substrate by:

(a) depositing a first material to a location on the substrate, and

(b) supplying energized particles of a second material different than the first material to the substrate adjacent the location to control growth of a crystalline structure of the first material at the location;

forming an electrolyte second layer on the first layer; and

forming a third layer on the electrolyte second layer,

after performing the above steps, cryogenically annealing the energy-storage device.

102. The method of claim 101, wherein supplying energized particles includes supplying energized ions.

103. The method of claim 102, wherein cryogenically annealing the energy-storage device includes exposing the energy-storage device to liquid nitrogen vapor.

104. The method of claim 102, wherein cryogenically annealing includes lowering the temperature of the energy-storage device to a near cryogenic temperature, then raising the temperature to a near deposition temperature, and then cooling the energy-storage device to an ambient temperature.

105. The method of claim 104, wherein the lowering, raising, and cooling steps are repeated.

106. The method of claim 104, wherein the lowering, raising, and cooling steps are repeated less than six times.

107. The method of claim 73, wherein cryogenically annealing includes first packaging the device prior to cryogenically annealing.